A bibliometric review of the STEAM approach in university education 2010-2022

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Cite as: Tapullima-Mori, C., Pizzán-Tomanguillo, S., Pizzán-Tomanguillo, N., Gómez Sangama, L., Vásquez Sánchez, M., Iñipe Cachay, M. (2024). A bibliometric review of the STEAM approach in university education 2010-2022. *Revista Digital de Investigación en Docencia Universitaria, 18(1)*, e1790. https://doi.org/10.19083/ridu.2024.1790

Received: 11/03/2023. **Received: :** 6/12/2023. **PPublished:** 30/01/2024.

Abstract

Introduction: The present study sought to explore and characterize the scientific production of the STEAM approach in university education. **Method:** The bibliometric design study that analyzed the SCOPUS database, used the VOSviewer program, analyze search and the PRISMA methodology. **Results:** The STEAM approach has been developed in the field of university education since 2010; however, its continuity between 2012 and 2014 was affected. Countries such as the United States and Spain are leaders in scientific production in high-impact journals (Q1); in addition, the results reflect the adequate applicability of the STEAM approach in the university context. **Discussion:** The studios pose a marked line of studies such as social sciences and engineering, as it allows the development of diverse skills in the students and promotes the solution of conflicts and innovation; however, the results must be analyzed with caution.

Keywords: STEAM; STEM; university education; bibliometry; pedagogy

Una revisión bibliométrica del enfoque STEAM en educación universitaria 2010-2022

Resumen

Introducción: El presente estudio buscó explorar y caracterizar la producción científica del enfoque STEAM en la educación universitaria. **Método:** El estudio fue de diseño bibliométrico que analizó la base de datos de SCOPUS, se utilizó el programa VOSviewer, analyze search y la metodología PRISMA. **Resultados:** El enfoque STEAM se ha desarrollado en el campo de la educación universitaria a partir del 2010; no obstante, su continuidad entre 2012 y 2014 se vio afectada. Países como Estados Unidos y España lideran en la producción científica en revistas de alto impacto (Q1); además, los resultados reflejan la adecuada aplicabilidad del enfoque STEAM en el contexto universitario. **Discusión:** Los estudios poseen una marcada línea de estudio como ciencias sociales e ingeniería, por lo que permite el desarrollo de diversas habilidades en los estudiantes y promueve la solución de conflictos e innovación; no obstante, los resultados tienen que ser analizados con precaución.

Palabras clave: STEAM; STEM; educación universitaria; bibliometría; pedagogía

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Introduction

In research, bibliometrics is used for the study of bibliographic material through the application of a quantitative method (Broadus, 1987) and has recently been gaining popularity (Donthu et al., 2021) due to the necessity to analyze large volumes of data or metadata, which makes it possible to identify various characteristics of a subject, journal, authors, affiliations, and other criteria that are necessary to quantify for decision-making, mainly in the fields of health (Cao et al., 2021; Mougenot & Herrera-Añazco, 2022), finance (Khan et al., 2022), and education (Brika et al., 2021). In the latter, it has been used because of its quality linked to various mechanisms, tools, methods, or technological approaches.

According to this, the introduction of digital media or tools reaches a greater presence in society. The Science, Technology, Engineering, Arts and Math (STEAM) pedagogical approach is an interdisciplinary integrative method related to education in science, technology, engineering, mathematics and art (Park et al., 2020) that favors the understanding between art and STEM elements for the growth of all areas (Johnston et al., 2022). In this way, it is considered a very robust alternative for education at the university level, which is key to improving creativity, innovation, and conflict resolution, as well as increasing participation (Domínguez et al., 2019; Putri et al., 2023), as evidenced by a growing number of studies on the subject (Ortiz-Revilla et al., 2021).

Several studies have addressed the STEAM approach (Duo-Terron et al., 2022; Fuentes et al., 2023; Ngoc-Huy et al., 2021; Perales & Aróstegui, 2021) because of the transversal teaching-learning processes (Cuervo & Reyes, 2021; Marín-Marín et al., 2021) and have primarily focused on the characterization of origin, thematic areas, as well as the impact the studies achieved in the main databases such as Scopus and Web Of Science (Díaz et al., 2022), thus achieving not only a descriptive record of emerging technologies in education, but also, demonstrating their high popularity and applicability in education. However, most of the documents have focused on a more generic level, which makes it impossible to make more accurate decisions on the specific topic of STEAM in university education, especially when it comes to methods focused on innovation, creativity, and development of multiple capabilities of students.

In this sense, developing a bibliometric analysis of the STEAM approach in higher education is important to objectively explore how it has been evolving in recent years and to what extent it can be applied to all contexts, from countries with high educational levels to those that are developing. Based on this, the study's main objective is to explore and characterize the scientific literature of the STEAM approach in university education, showing the evolution between 2010 and 2022, the most representative countries, the thematic development, the main affiliations and institutions, as well as authors and impact studies, leading to a co-analysis of authors and words, ending with the systematization of the selected documents, in order to provide relevant information for future researchers.

Method

Research Design

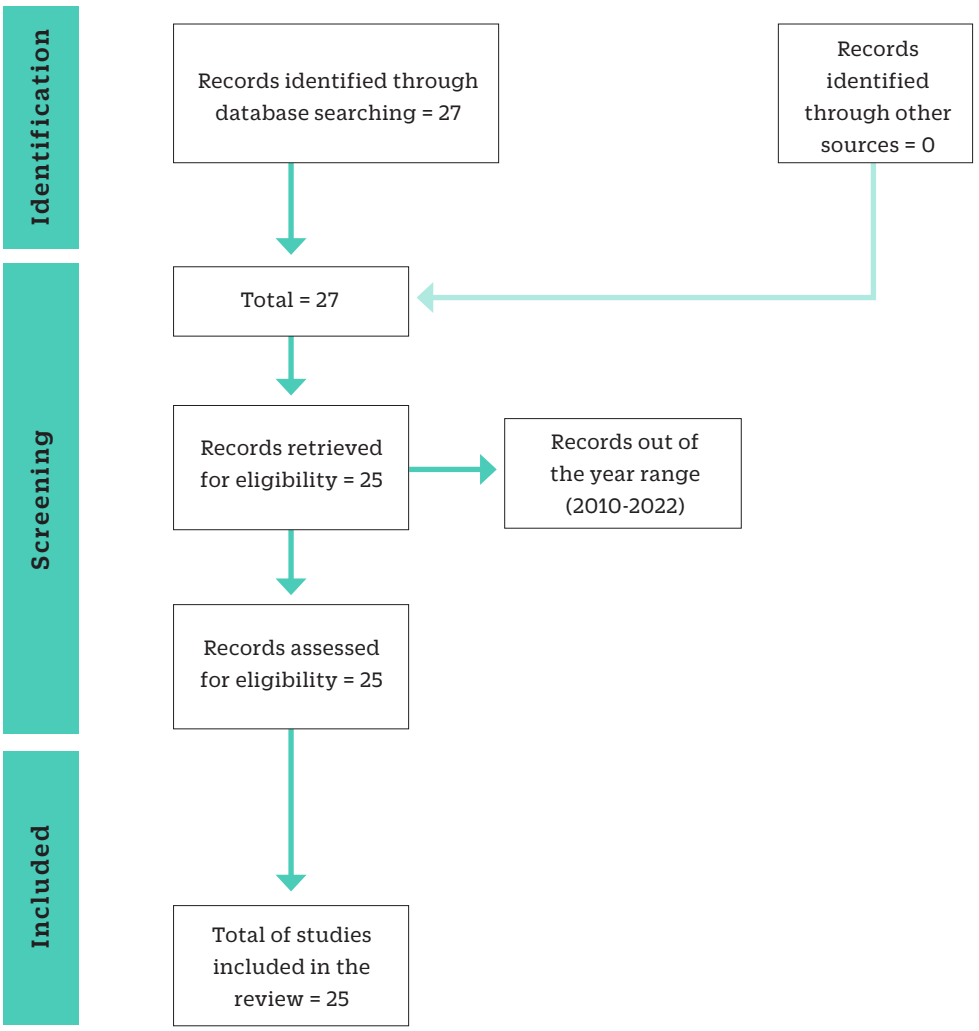
For the development of the study, a bibliometric design has been used (Mejia et al., 2021; Wilson, 2016) because it allows quantifying and analyzing the documents indexed in high impact scientific research databases with greater precision. In this sense, the research design makes it possible to clarify the processes of search, registration, analysis, and prediction of studies regarding the STEAM approach in university education. The study also considered the co-analysis of keywords and main authors (Lin et al., 2022), thus obtaining information regarding the trends of studies that are linked and their relevance to the community through the creation of keyword networks.

Likewise, the main studies were systematized in order to provide relevant data for the interpretation and understanding of STEAM in contemporary university education.

Procedure

In order to avoid bias in the study, a thorough process was designed, starting with the selection of the SCOPUS database, because it includes more than 27,339 high impact journals and has easy navigation and access to articles (Livia et al., 2022). Then, the descriptors or search terms "STEAM, STEM, STEAM approach, science, technology, engineering, arts and mathematics, STEM Education, STEAM Education, University education" were defined. Using the terms and the Boolean operators (AND, OR), the search equation was formulated combining the title, abstract, and keywords in the SCOPUS search engine [TITLE-ABS-KEY (steam OR "STEAM Approach" OR "science, technology, engineering, arts and mathematics" OR "STEM education" OR "STEAM education" AND "University education")]. A total of 27 suitable documents were obtained. After that, results were limited to the years between 2010 and 2022 (2023 was not considered because it is still under development), thus obtaining 25 articles. In addition to this procedure, the standardized PRISMA protocol (Moher et al., 2009; Tricco et al., 2018) was used to delimit and summarize the selected studies in order to present information about their expansion and dissemination in university education (Figure 1).

Figure 1
Flow Chart according to PRISMA Statement



Data Analysis

The articles were filtered considering their time frame and university scope of the STEAM approach, and then the SCOPUS tool "analyze search results" was used to obtain data on the evaluation of bibliographic production, countries, areas of knowledge, institutional affiliations, journals with the highest productivity, authors, and citations of the main articles. Subsequently, the documents found on the STEAM approach were systematized in order to demonstrate its efficiency in university education. In addition, the analysis of co-occurrence of main authors who have been cited at least once was carried out, as well as the analysis of co-occurrence of key words. In the case of keywords, they were grouped by a minimum of two repetitions in order to establish topics for future approaches. Previously, the information was exported in RIS format specifying the citation information, bibliography, and key words.

Results

Scientific Production

The results include 25 papers on the STEAM approach in undergraduate education from 2010 to 2022, registering an increase in scientific production from 2015 and a higher peak in 2020 and 2021 due to the methods used in online education due to health restrictions (Figure 2). Forty-eight percent (48%) of the documents found correspond to conferences and thirty-six (36%) to scientific articles (Table 1) related to various debates on STEAM application and measurement in university education to understand it.

Table 1

Document Type on the STEAM Approach in University Education

Type	f	%
Conference paper	*12*	*48%*
Article	*9*	*36%*
Book chapter	*2*	*8%*
Conference review	*1*	*4%*
Letter	*1*	*4%*
Total	*25*	*100%*

Table 2 shows the countries with the highest worldwide scientific production on the STEAM approach in university education. The United States and Spain lead the list with a total of 60%, followed by Portugal and Japan with 12% and 8%, respectively.

Figure 2

Published Works on STEAM in University Education (2010-2022)

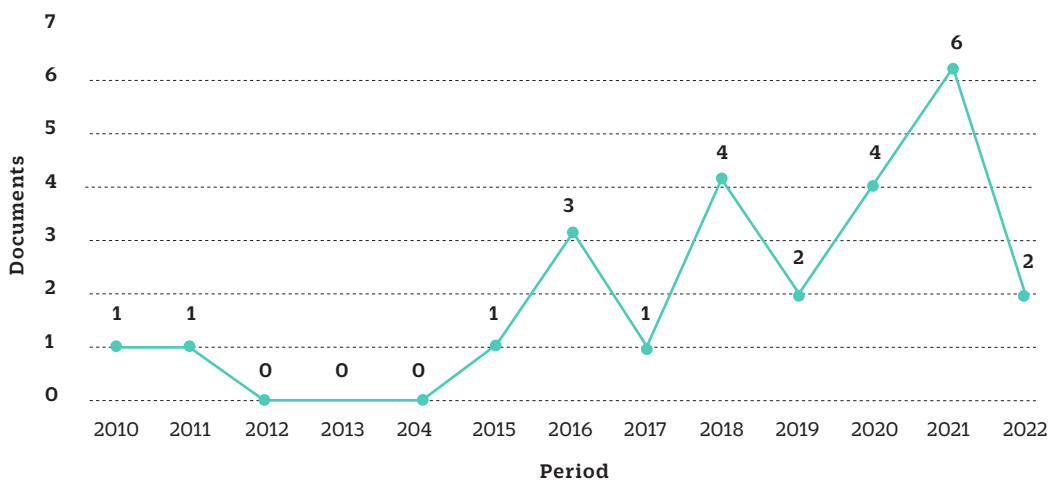


Table 2
Countries with Scientific Production on STEAM in University Education

Countries	f	%
United States	*8*	*32%*
Spain	*7*	*28%*
Portugal	*3*	*12%*
Japan	*2*	*8%*
Others	*5*	*20%*
Total	*25*	*100%*

Thematic Development

The STEAM approach is most widely applied in university social science education with 31.1% followed by 24.44 % in engineering, 17.78 % in IT, and 26.64% in other scientific disciplines. It is increasing due to the demand for tools or mechanisms for the proper development of academic activities (Table 3).

Institutions and Journals

In terms of productivity by institution, 38 institutions have participated in the production of the STEAM approach in university education. Table 4 shows the summary of the top 10, in which institutions from Spain and Portugal stand out. Even though they are not within any level of the QS World University Rankings 2023, the scientific production that originates its application and benefit to the university education community is significantly valued.

Table 3
Areas of Knowledge

Áreas	f	%
Social Sciences	*14*	*31.11%*
Engineering	*11*	*24.44%*
IT	*8*	*17.78%*
Earth and Planetary Sciences	*2*	*4.44%*
Mathematics	*2*	*4.44%*
Physics and Astronomy	*2*	*4.44%*
Business, Management and Accounting	*1*	*2.22%*
Economics, Econometrics and Finance	*1*	*2.22%*
Energy	*1*	*2.22%*
Environmental Sciences	*1*	*2.22%*
Multidisciplinary	*1*	*2.22%*
Psychology	*1*	*2.22%*
Total	*45*	*100.00%*

Table 4
Participating Institutions in the Production on STEAM in University Education

Institution	Country	QS World University Rankings 2023	Documents
Universidad de León	*Spain*	-	*3*
Universidad de Salamanca	*Spain*	-	*3*
Instituto Politécnico de Braganca	*Portugal*	-	*3*
Universidad de Extremadura	*Spain*	-	*2*
La Petite Noiseuse Productions	*United States*	-	*1*
Kitauwa High School	*Japan*	-	*1*
Environics Analytics	*Canada*	-	*1*
Villanova University	*United States*	-	*1*
Pennsylvania State University	*United States*	*93*	*1*
Ehime University	*Japan*	-	*1*

Twelve journals that analyze the STEAM approach in university education were found. Table 5 shows the summary of the top 5 journals that belong to the United States (ACM International Conference Proceeding Series; IEEE Transactions On Education), followed by the Netherlands, Switzerland, and Japan. Furthermore, these are in the Q1 category with an SJR 2021 ranging from 0.219 to 0.884, which are mostly oriented towards social science, engineering, and computer science.

Relevance of Authors and Articles

Table 6 shows the most representative authors of the scientific production on the STEAM approach in university education. Among the 81 authors, five main authors stand out, such as Conde-Gonzáles, Carvalho, Lima, Ahmad, and Allen, with 8 works in general and an H-index ranging from 9 to 26, which reflects a high citation average. The researchers are mainly from Spain, Portugal, the United States, and Qatar, thus representing a high degree of diversity.

The 25 articles found were submitted to an analysis of citation relevance in the Scopus database. Of these, 37.5% were published in 2020 and 25% in 2021, and had achieved a minimum average of 4 citations and a maximum of 18 citations in high impact scientific journals indexed in Scopus (Table 7).

Of the 62 registered authors, the analysis found two main clusters in which similar citation indexes are evidenced among the registered texts; that is, a map of nine authors with the highest citation level within the research context was registered (Figure 3).

The keyword co-analysis was developed using the free VOSviewer software in its version 1.6.19. It began with the selection of 25 terms from the 170 existing ones related to the 25 retrieved articles that were grouped into two clusters. Cluster 1 (red) included results of studies on the application of STEM and STEAM in the field of engineering (robotics, software programming,

Table 5
Journals with the Highest Productivity on STEAM in University Education

Name of journal	Doc.	Country	Quartile	SJR 2021	Category
ACM International Conference Proceeding Series	*3*	*United States*	*-*	*0.232*	*IT*
Frontiers In Psychology	*1*	*Switzerland*	*Q1*	*0.873*	*Psychology*
Heliyon	*1*	*Netherlands*	*Q1*	*0.550*	*Interdisciplinary*
IEEE Transactions On Education	*1*	*United States*	*Q1*	*0.884*	*Social sciences; engineering*
Ieej Transactions On Fundamentals And Materials	*1*	*Japan*	*Q3*	*0.219*	*Engineering*

Table 6
Authors with the Highest Impact (H index)

Author	Institution	Country	H index	Documents
Conde-González, Miguel Ángel	*Universidad de León*	*Spain*	*25*	*2*
Carvalho Gonçalves, José A.	*Instituto Politécnico de Braganca*	*Portugal*	*9*	*2*
Lima, José	*Instituto Politécnico de Braganca*	*Portugal*	*13*	*2*
Ahmad, Zubair	*Universidad de Qatar*	*Qatar*	*26*	*1*
Allen, Jeffrey S.	*Universidad Tecnológica de Michigan*	*United States*	*14*	*1*

IT, and computer science), and how these areas can provide solutions to specific problems within a field of action. Cluster 2 (green) includes studies on the teaching of STEM and STEAM in university education for the various programs, enabling better learning by using electronic media for the acquisition of scientific knowledge.

Table 7
Articles with the Highest Number of Citations

Document title	Type of document	Autor	Journal	Citatios in Scopus
Exit for success. Gamifying science and technology for university students using escape-room. A preliminary approach	*Article*	*(Sánchez-Martín et al., 2020)*	*Heliyon*	*18*
Interdisciplinary teaching using satellite images as a way to introduce remote sensing in secondary school	*Letter*	*(Dziob et al., 2020)*	*Remote Sensing*	*8*
A STEM Course Analysis During COVID-19: A Comparison Study in Performance and Affective Domain of PSTs Between F2F and F2S Flipped Classroom	*Article*	*(Jeong & González-Gómez, 2021)*	*Frontiers in Psycholo-gy*	*7*
Nature of Science and Nature of Scientists: Implications for University Education in the Natural Sciences	*Article*	*(Mohan & Kelly, 2020)*	*Science and Education*	*6*
Is STEM Education Portable? Country of Education and the Economic Integration of STEM Immigrants	*Article*	*Boyd & Tian, 2018)*	*Journal of International Migration and Integration*	*5*
A Systematic Interdisciplinary Engineering and Technology Model Using Cutting-Edge Technologies for STEM Education	*Article*	*(Huang et al., 2021)*	*IEEE Transactions on Education*	*4*
Computational thinking and robotics in education	*Conference papers*	*(García-Peñalvo et al., 2019)*	*ACM International Conference Proceeding Series*	*4*
"I told you this last time, right?": Re-visiting narratives of STEM education	*Conference papers*	*(Dziallas & Fincher, 2018)*	*International Computing Education Research*	*4*

Figure 3
Co-analysis of Authors

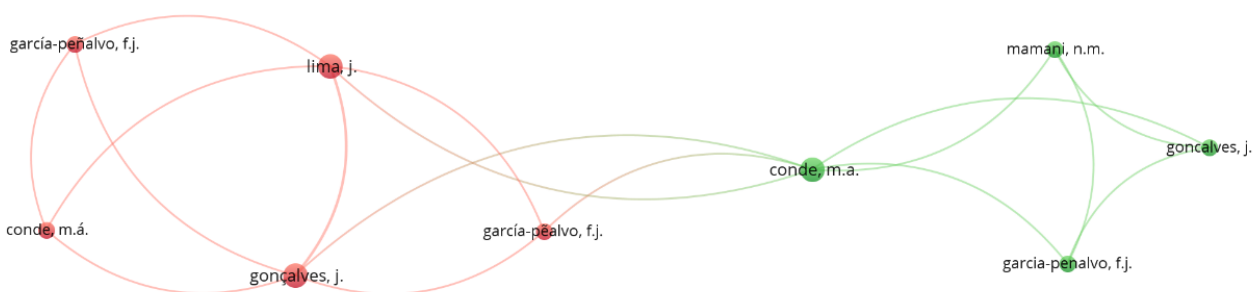
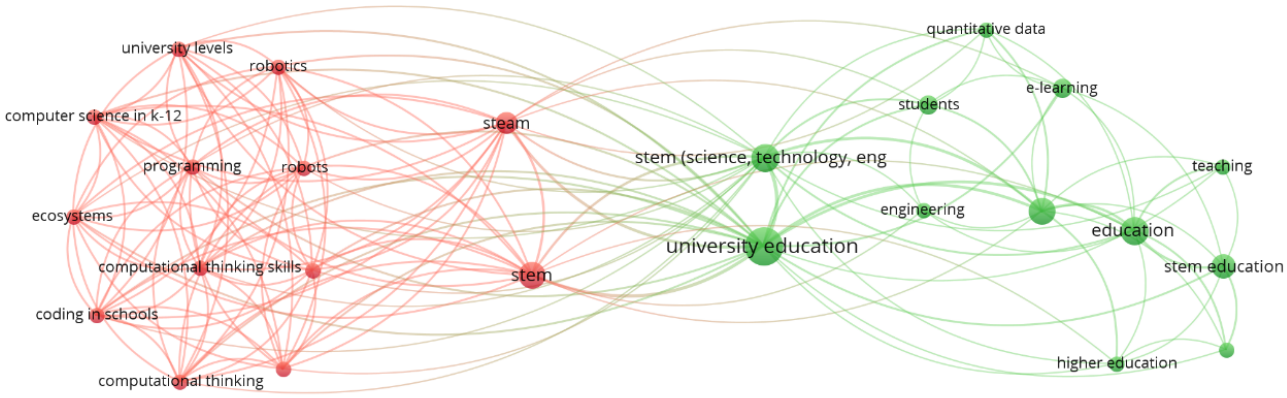


Figure 4
Co-analysis of Terms or Keywords



Eficiencia del STEAM en la educación universitaria

After the review and theoretical analysis of the information, it is acknowledged that the STEAM approach has a high level of effectiveness in most of the documents reviewed because the shortcomings or drawbacks presented during its implementation and/or application were minimal. This information is reflected through the assertive student participation and continuous feedback from the professor (Hödl et al., 2022; Jeong & González-Gómez, 2021; López González, 2017; Mohan & Kelly, 2020), the development of creative thinking (García-Peñalvo et al., 2021; Huang et al., 2021), the empowerment to solve problems effectively and in a timely fashion (Castro-Rodríguez & Montoro, 2021; Huang et al., 2021; Keith et al., 2011), the application of the contents covered to real situations that occur on a daily basis (Castro-Rodríguez & Montoro, 2021), as well as the fulfillment of the learning goals established for the educational period (Coleman et al., 2017; García-Peñalvo et al., 2019; Keith et al., 2011; Stanko et al., 2019; Yamada, 2016). Therefore, to ensure the effectiveness of the application of this approach, the competent educational actors consider it essential to study the educational context where it is intended to be applied and to implement the necessary measures to ensure the minimum presence of limitations in order to ensure the achievement of favorable results by university students through the development of their activities under the STEAM approach (Table 8).

Table 8
Systematization of the Efficiency of the STEAM Approach

Author	Conclusion	Limitation
Sellami et al. (2022)	*The methodology was unsuccessful because of the barriers that professors faced, which has led to a negative interaction with students because they are not involved in their learning.*	*Lack of teaching competencies and skills, low motivation level of students, lack of modernization in the educational process.*
Hödl et al. (2022)	*The lack of significant shortcomings has led to the effective implementation of the approach, as it promoted the assertive feedback and participation of students, contributing to improve their competencies, increase their knowledge and achieve their learning goals.*	*Inaccuracy in the scope of the contents to be covered.*

Vargas & Gar-cía (2021)	*The educational methodology represents an emerging line of research, and its implementation allows professors to develop their creative and innovative skills in the delivery of classes. In most cases, this methodology is not correctly applied in the educational process.*	*Lack of resources or minimum materials required professors' lack of knowledge.*
Huang et al. (2021)	*The implementation of the computer-based instructional model has been favorable for the educational process, since its effectiveness and efficiency have allowed students to develop their thinking skills, strengthen their problem-solving skills, and easily transfer their knowledge.*	*Continuous development of new technologies.*
Mamani et al. (2021)	*The changes experimented in the learning process during the last few years have motivated the implementation of new technological models oriented to facilitate the execution of relevant educational topics; nevertheless, these are not being effectively applied in all contexts due to different limitations.*	*Constant innovation of new technological tools.*
Jeong & Gon-zález-Gómez (2021)	*The pedagogical methodology applied has had a positive effect on the learning process because it has promoted the development of their capacity for interaction and management of negative attitudes during the development of the classes, which resulted in a significant increase in students' grades.*	*Low level of student interest.*
Castro-Rodríguez & Montoro (2021)	*The educational program proved to be efficient because it allowed students to solve problems with ease, apply educational content in a real situation, develop their activities in an interdisciplinary manner, and use technological tools appropriately.*	*Well-defined educational guidelines, lack of appropriate competencies on the part of professors, low level of student knowledge.*
García-Peñalvo et al. (2021)	*The use of this pedagogical tool during the learning process was effective because it has contributed to the development of thinking skills, continuous practice of skills, and achievement of the goals established in the curricula.*	*Constant innovation of new technological tools.*
Mohan & Ke-lly (2020)	*The application of this educational tool increases the level of student participation during the activities and educational practices, thus contributing to a quick and easy understanding of the subjects covered.*	*Constant innovation of new technological tools.*
Dziob et al. (2020)	*This tool is well applied and effective because it covers a variety of educational competencies, contributing to broaden students' knowledge through the effective use of resources and applied educational techniques.*	*Lack of knowledge and skills of professors.*
Sánchez-Martín et al. (2020)	*The application of this pedagogical tool proved to be successful in the university educational context, since it enabled learning activities to be carried out appropriately, thus favoring their acceptance and good performance.*	*Low level of student interest*

García-Peñalvo et al. (2019)	*The application of this educational methodology has favored the learning process, as it has contributed to the organization of information in order to achieve the educational goals foreseen for an educational period.*	*Constant innovation of new technological tools.*
Stanko et al. (2019)	*The use of this educational model contributes to the enrichment of the educational plan, guaranteeing that students acquire and develop the necessary skills to adequately perform their learning sessions and meet the established goals.*	*Absence of a personalized educational plan.*
Boyd & Tian (2018)	*This model is not applied efficiently in the context studied because the presence of deficiencies has limited the students' ability to effectively carry out their activities and acquire the expected knowledge.*	*Lack of minimum necessary resources or materials.*
Dziallas & Fincher (2018)	*This educational methodology has been effectively applied in the educational context, since it has allowed the acquisition of favorable educational experiences and new pedagogical practices, allowing the learning path to be considered broad and favorable.*	*Continuous modification of educational plans.*
López-González (2017)	*The use of this pedagogical methodology proved to be appropriate for the research setting in view of the fact that it has contributed to the increase of students' participation, reducing the presence of bias and strengthening the development of student competencies and skills.*	*Constant innovation of new technological tools.*
Fuqua et al. (2018)	*Despite the implementation of this approach, the lack of effectiveness in its use has hindered the resolution of the problems presented during the process of learning and enrichment of critical-analytical thinking, thus preventing the activities from being executed fairly.*	*Students' individual expectations, lack of resources.*
Bagiati et al. (2015)	*This approach has not been properly implemented in the context studied because the changes presented have originated significant deficiencies; therefore, it limited the development of educational practices oriented to the achievement of learning goals.*	*Constant innovation of new technological tools.*
Keith et al. (2011)	*This approach has enabled students to develop the skills and/or abilities necessary to solve the problems they encountered in class. It has also enabled professors to improve their educational work so that learning goals can be met in a timely and effective manner.*	*Deficient and unsuitable curriculum.*
Van et al. (2010)	*This approach requires improvement because it is not being properly implemented in the educational context and this prevented students from facing greater challenges, thus preventing the fulfillment of the educational goals foreseen for a period.*	*Lack of economic resources.*

Coleman et al. (2017)	*The pedagogical practice based on this model has led to a favorable learning process for the student regarding the achievement of educational goals because it allowed students to participate continuously during the execution of academic activities, thus contributing to the development of critical thinking.*	*Minimal level of knowledge and skills of professors.*
Yamada (2016)	*The use of the educational program was efficient because it allowed students to participate adequately in each learning process, which made it possible to guarantee the acquisition of the expected knowledge during the academic period.*	*Lack of commitment and student motivation, lack of resources.*

Discussion

Methodological approaches that apply STEAM in university education have recently emerged as elements of alternative pedagogy in search of a more holistic teaching-learning process, since their application has been more focused on primary or secondary education (Chen & Huang, 2020; Marín-Marín et al., 2021). As evidenced in the results, an increase was witnessed from 2016 onwards, as more studies were published in relation to the application of emerging technologies and new proposals for pedagogical approaches (Díaz et al., 2022). Although the topic was recorded from 2010, studies were unstable over time; even no works were published in the years 2012-2014. Countries such as the United States and Spain lead in the bibliographic production on the subject, because they implement active methodologies in learning; these are related to the greater presence of conference papers (48%) such as conference proceedings. The countries' performance is also related to the fact that every year digital media and tools are entering society to a greater extent (Marín-Marín et al., 2021).

The performance of scientific production has mainly considered the areas of social sciences (31.11%), engineering (24.44%), and IT (17.78%) under the various lines of research that have been formulated around STEAM in university education, due to the growing development of curricular contents that seek to optimize resources, equipment, and means to develop optimal communication channels after the recent Covid-19 health crisis (Do & Pham, 2021; Duo-Terron et al., 2022; J. Vargas et al., 2020), allowing to reach the largest possible number of individuals, which translates into better teaching and innovation processes. Their application has become recurrent in online learning environments due to the speed to form virtual classrooms, and they also allow the development of creative thinking along with innovation (Wannapiroon & Pimdee, 2022).

The main institutions that have published studies on the STEAM approach belong to Spain, Portugal, the United States, Canada, and Japan. On the other hand, the journals with the highest impact, such as ACM International Conference Proceeding Series, Frontiers In Psychology, and Heliyon, correspond to Switzerland, the Netherlands, and the United States, located in Q1 quartiles in their field of application. Although the presence of high impact journals has been evidenced, due to their citation and dissemination, there is a reduced number of authors with H-index higher or equal to nine, as a minimum base of the records found; in addition, the number of articles that were cited at least four times in Scopus is not high either. With respect to the authors, Conde, Gonçalves and García-Peñalvo had the highest number of citations, being considered as referents in their field of study. In the case of the studies' findings, the key words have emphasized the application of the STEAM approach in areas

such as engineering for the solution of concrete problems, and have also focused on the education in various programs oriented to the acquisition of new knowledge; however, they are still limited by the presence of new trends that have emerged in recent years (Marín-Marín et al., 2021).

The changes observed in recent years have led the educational system to implement new mechanisms and tools aimed at facilitating the development of learning activities (Mamani et al., 2021). In accordance with this premise, it is necessary to specify that the STEAM approach is considered one of the most exceptional pedagogical approaches because it seeks to strengthen the learning process of technical, scientific, and artistic skills in the educational field. That is, it seeks to foster students' interest in subjects related to science, technology, engineering, art, and mathematics through the development of relevant competencies; therefore, it is considered one of the most suitable educational tools that can be applied in the higher education context.

In some contexts, the application of this approach has been affected by certain limitations, which prevented university students from achieving optimal academic performance. Therefore, it is relevant to emphasize the main limitations that have been found in the scientific literature reviewed, such as the absence of competencies and skills on the part of professors (Castro-Rodríguez & Montoro, 2021; Coleman et al., 2017; Dziob et al., 2020; Sellami et al., 2022), low level of knowledge, interest and/or motivation on the part of students (Castro-Rodríguez & Montoro, 2021; Jeong & González-Gómez, 2021; Sánchez-Martín et al., 2020; Sellami et al., 2022; Yamada, 2016), lack of flexibility of pedagogical processes in the face of the changes that arise in the context of modernization (Bagiati et al., 2015; García-Peñalvo et al., 2021; Huang et al., 2021; López-González, 2017; Mamani et al., 2021; Sellami et al., 2022), absence of an educational plan containing clear and properly defined contents (Castro-Rodríguez & Montoro, 2021; Dziallas & Fincher, 2018; Hödl et al., 2022; Keith et al., 2011; Stanko et al., 2019), as well as lack of materials and human, material, economic and/or financial resources (Boyd & Tian, 2018; Fuqua et al., 2018; Van et al., 2010; Vargas & García, 2021; Yamada, 2016). These limitations prevent the proper application of the STEAM approach in university education. What has been described above is related to what has been stated by Fuentes et al. (2023), who refer that the presence of economic, curricular, and even temporal limitations directly impact the implementation of the STEAM approach within the educational community. Faced with this reality, it is necessary to make use of the unlimited resources that artificial intelligence currently provides, such as the case of GPT Chat, which is a potential transformer in the field of education (Cooper, 2023), and combine it with educational approaches to obtain better results for students.

The results of the study will contribute with relevant information to promote the implementation and evaluation of emerging technologies in the educational field in Latin America, as well as to strengthen emerging methods on the use of technologies in pedagogical practice.

Based on the results obtained, it is evident that the scientific production on the STEAM approach in university education has had an unstable increase in recent years, mainly reflected in conference papers and articles from the United States and Spain. The area of social science and engineering have applied this thematic concept with studies registered in high impact journals within the Q1 quartile. In addition, the most representative authors reached an H-index from nine, while the representative articles were cited at least four times. The keyword analysis reflected the importance of its application in engineering and university education; finally, it was possible to identify that the STEAM approach generally performs efficiently.

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